

Creating Malleable Interactive Surfaces using Liquid Displacement Sensing

Otmar Hilliges¹, David Kim¹, Shahram Izadi²

¹University of Munich, ²Microsoft Research Cambridge

- Novel approach to building multi touch surfaces, sensing
- Multiple fingertips
- Whole hands and objects
- Distinct signal and user experience



Embedded multi touch sensing Capacitive Sensing

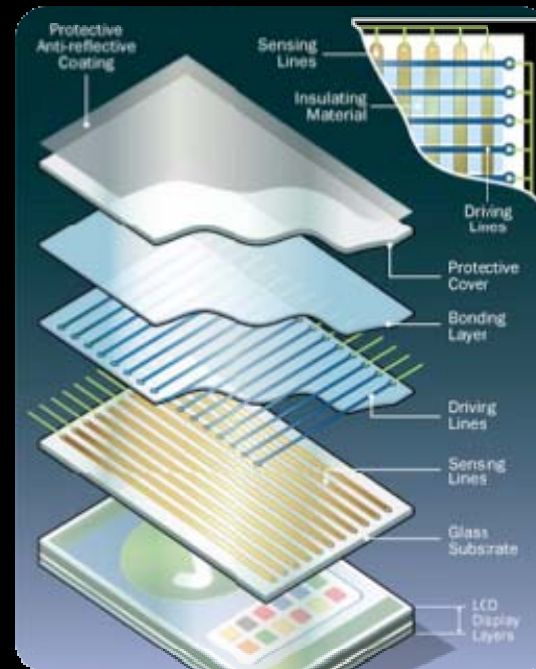


[Dietz Leigh'01]



[Rekimoto'02]

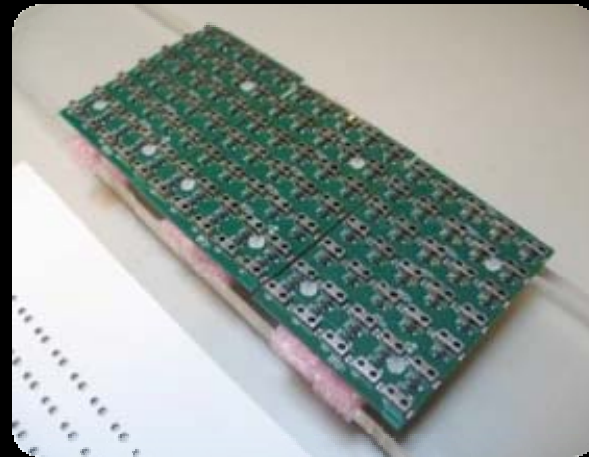
Embedded multi touch sensing Capacitive Sensing



Embedded multi touch sensing Resistive Sensing

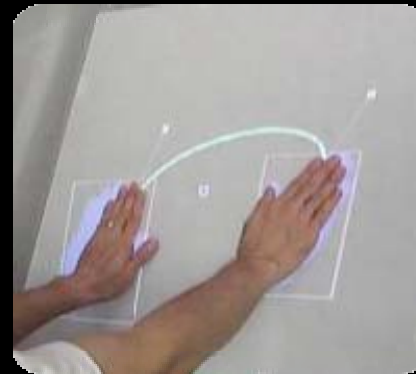


Embedded multi touch sensing IR Photodiodes



[Hodges et al.'07]

Camera Based Sensing Diffuse Illumination

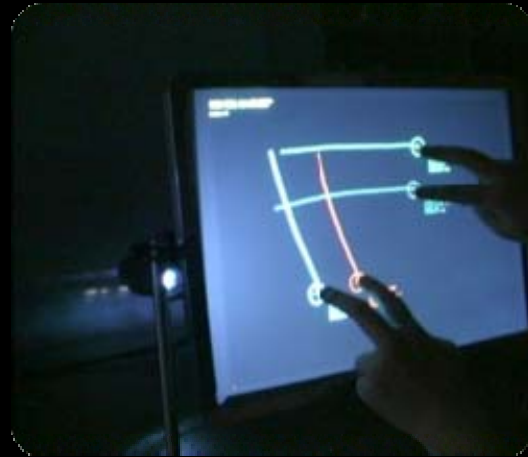
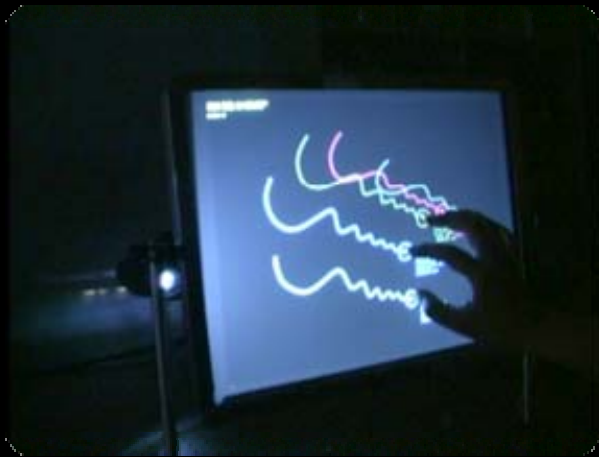


[Rekimoto Matsushita'97]



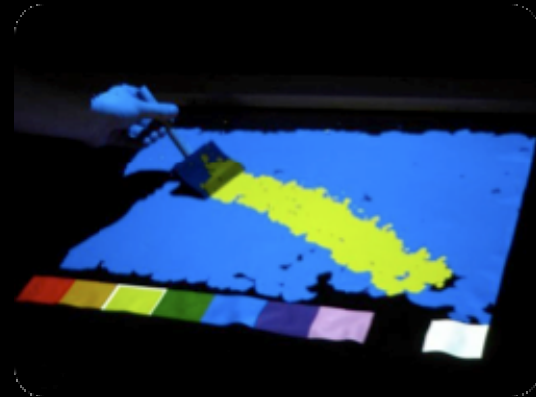
[Wilson'04]

Camera Based Sensing Frustrated Total Internal Reflection

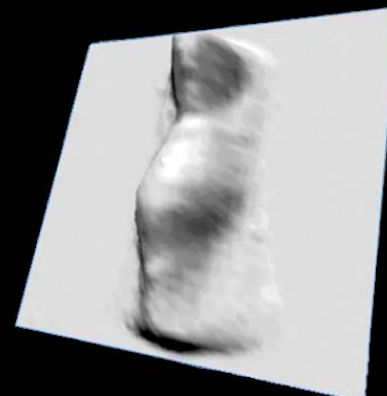
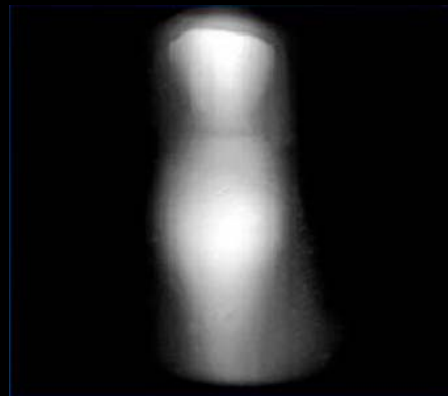


[Han'05]

Camera Based Sensing Malleable Surfaces



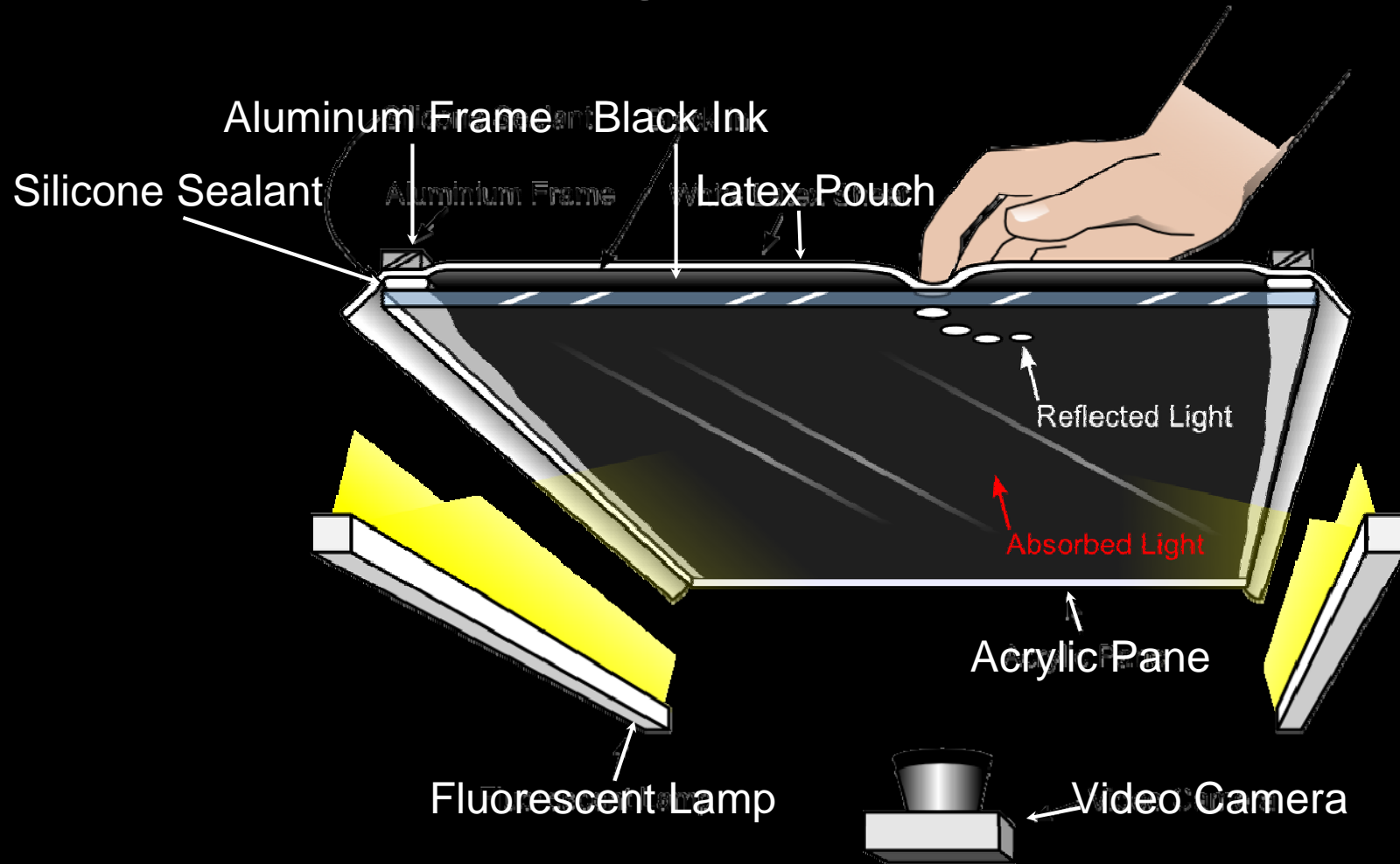
[Smith et al.'07]



[Sinclair '97]

Liquid Displacement Sensing

Overview

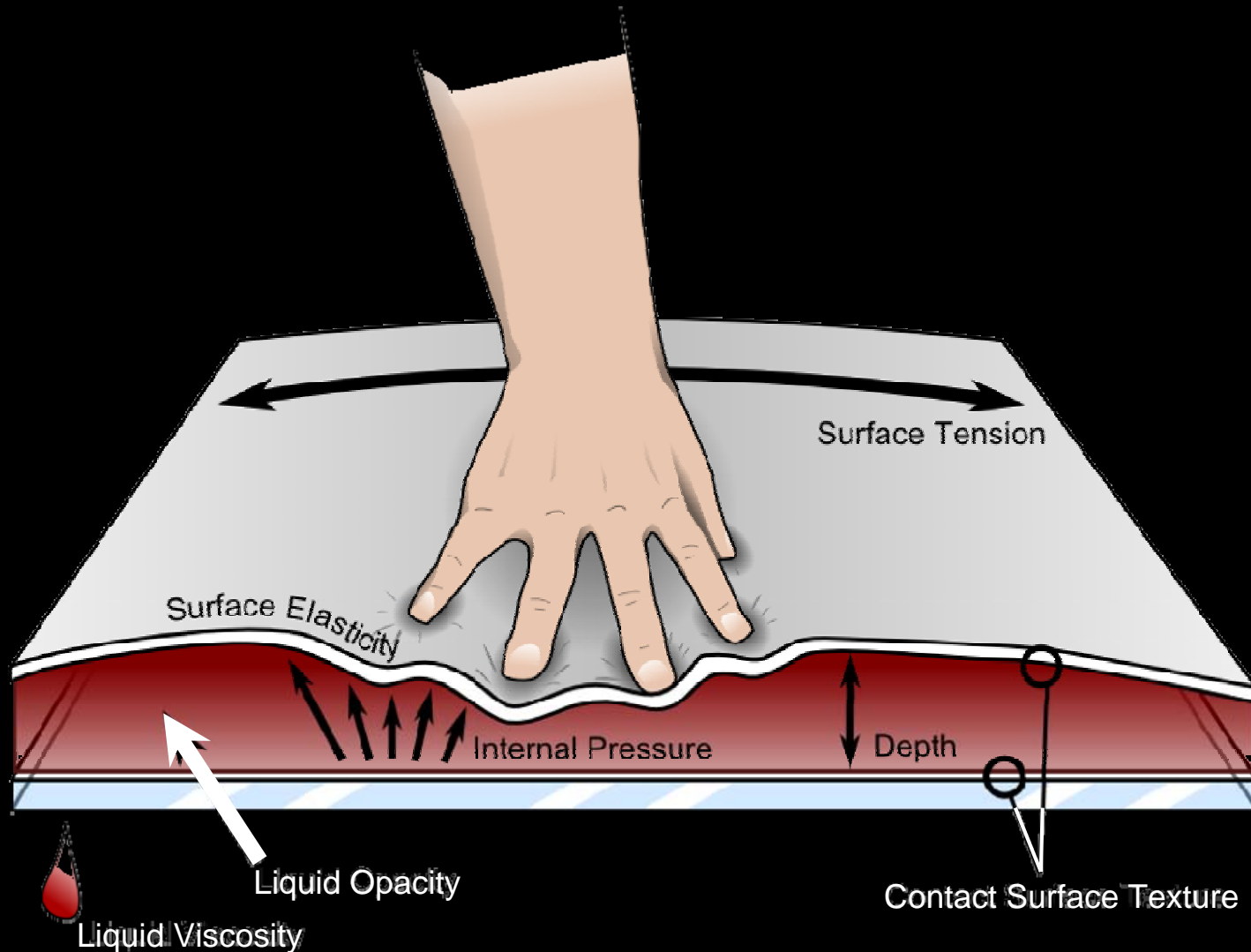




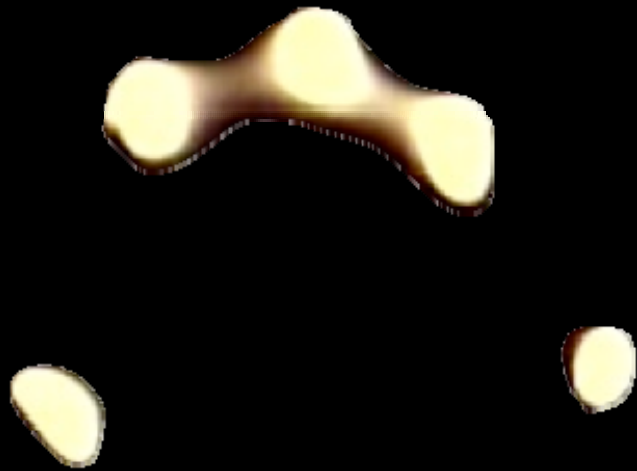
Liquid Displacement Sensing

-

Material Properties



Material Elasticity



too thick & rigid



appropriate thickness

Material Elasticity

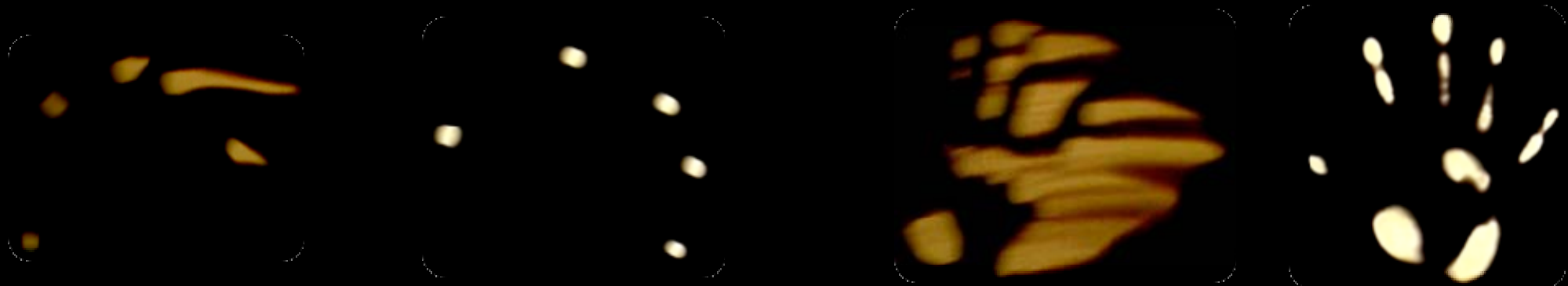


rippling effect



distortion caused by ripples

Surface Tension

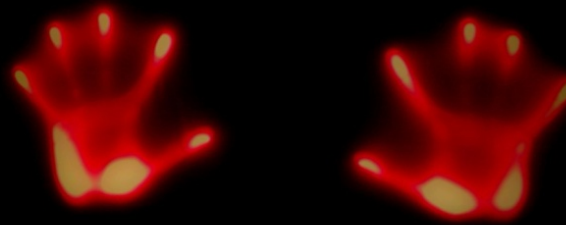


Pouch Pressure

- Internal Pressure can reduce rippling effect and motion blur
- Air-gap between ink and surface
- Reduces deformation hysteresis
- Suppresses waves within the liquid

Liquid Viscosity and Tint

- High viscosity fluids (oil, gels)
 - Can reduce rippling and bridging effect
 - Increase Motion blur
- Liquid tint & opacity
 - Black liquid provides high contrast
 - Colored & transparent liquids allow for pressure, depth sensing

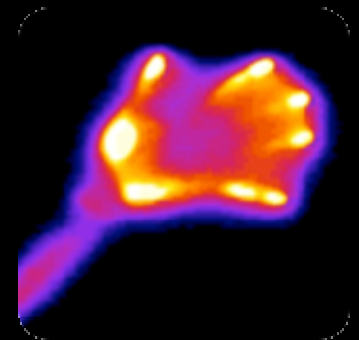


Liquid Volume

Raw Sensor Data -
No Image Processing Applied



Pressure Sensitivity:
Different Colors and Opacity of Dyes
Increased Liquid Volume



Conclusion

- New approach for rapid prototyping of multi-touch and object sensing surfaces
- Soft and malleable
- Recognition of shapes and outlines of objects
- Works without IR Illumination
- High signal-to-noise ratio

Future Work

- Camera based system requires space behind the panel
- Works only for horizontal surfaces
- Rear projection not possible currently
- Applications that exploit specifics of the signal

Questions? - Thank You!

